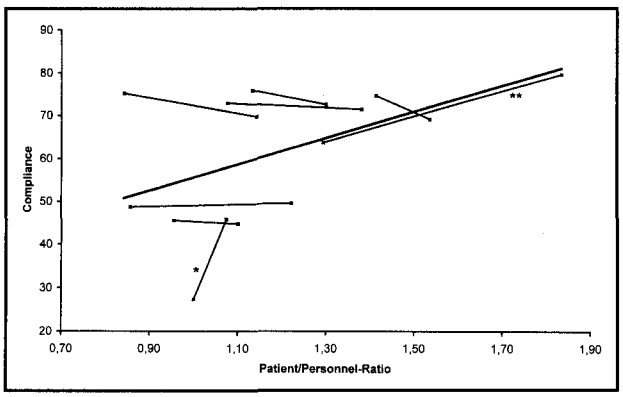

FIGURE. Compliance with hand disinfection or hand washing according to patient:personnel ratio from two observation periods in eight individual intensive care units.

reduce their frequency of hand washing due to their lack of time?

To proffer further material for this discussion, we wish here to report on our experience.

Within an interval of 2 years, we performed two observational studies in eight medical-surgical ICUs in medium-sized hospitals in Germany. The same medical student documented the frequency of hand disinfection or hand washing by medical personnel performing patient device manipulation that requires this procedure, according to most guidelines for the prevention of infection in ICUs. Manipulation of respiratory equipment, vascular catheters, and urinary catheters was included, as well as the changing of dressings. The investigator spent two 8-hour working days during each observation study in the ICUs. In addition, she recorded the number of patients and personnel on each observation day. Compliance was calculated as the quotient of hand disinfection or handwashing procedures for all device manipulations.

A total of 2,170 observations were recorded, with between 72 and 318 during a single observation period. The overall compliance with hand disinfection or hand washing was 61.7%, ranging widely from 27.4% to 79.8% between units and observation periods. The overall patient:personnel ratio was 1.20, ranging from 0.84 to 1.8. In the Figure, compliance is plotted against the patient:personnel ratio. The data from the two observation periods in an individual ICU are connected by lines. In six hospitals, almost no change of compliance was observed with varying patient:personnel ratio. In one hospital (marked with one star), despite a similar patient:personnel ratio, a remarkable increase of compliance was found, but in another hospital (marked with two stars), the compliance also increased with a more unfavorable patient:personnel ratio. In general, no trend for decrease of compliance with increase of the patient:personnel ratio was observed (thick line).

Of course, our results should be interpreted carefully:

1. The situation in adult ICUs may be different from neonatal ICUs where newborn babies are cared for in isolators.

2. The more often observed practice of hand disinfection as opposed to hand washing in German ICUs may indeed be connected with behavioral patterns on the part of the medical personnel when subjected to understaffing or overcrowding situations.

3. In calculating the crude patient:personnel ratio, the qualification of personnel was not considered. It is possible that, among a high number of personnel, a high percentage were not well trained, and thus, despite a large number of personnel, many mistakes in patient care could arise.

4. The number of observations is small, and the observation periods were short, so our results may perhaps be somewhat random.

In all, however, the question of the influence of understaffing and overcrowding on the frequency of hand disinfection or hand washing remains unsolved. It may even be possible that staff are more fully aware of the requirement of hand disinfection or hand washing in these exceptional and particular situations, thereby heightening their normal compliance with hygiene directives.

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The authors reply.

We are indebted to our German colleagues for taking the trouble to comment on our article[1] and earlier work performed by Haley and Bergman[2] about understaffing and overcrowding and their relation to poor compliance with hand-hygiene practices and transmission of nosocomial pathogens. Being mindful of space limitations, we will not attempt to reply to all issues related to this complex topic. However, we would like to address the following points:

1. The overall compliance with hand hygiene in the observed German intensive care units (ICUs) was astonishingly high compared to our[3] and others' observations in different types of ICUs. In our outbreak investigation,[1] compliance with hand hygiene before device contact was 25% during the work-load peak and increased to 70% after the end of the understaffing and overcrowding period. We believe that the availability of bedside hand disinfection contributed to the favorable findings in the German ICUs and agree with Eckmanns et al that fast-acting alcohol-based hand disinfection solutions within close patient range may limit noncompliance, especially in periods of increased time pressure and work load. We recently reported the encouraging results of a large hospitalwide promotion campaign,[4] based on better understanding of major risk factors for poor compliance[3]: among several key components, the availability of alcohol-based hand rub at the patient

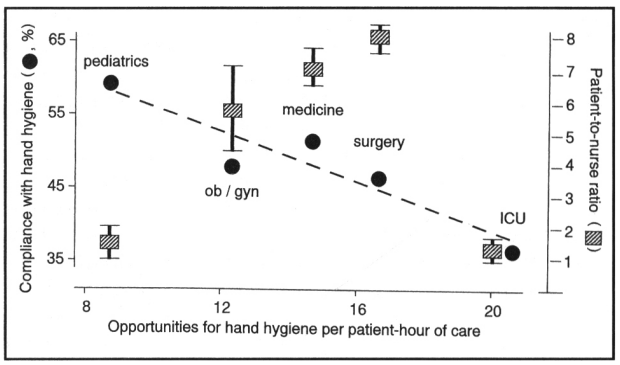

FIGURE. Relation between opportunities for hand hygiene, nurse staffing, and compliance across hospital wards. Average compliance with hand hygiene (dark circles) observed in different hospital wards (pediatrics, internal medicine, surgery, obstetrics-gynecology, and intensive care units) is plotted as a function of the average number of opportunities for hand hygiene per patient-hour of care. The relation between these two parameters is indicated (hashed bar). The average patient-to-nurse ratio (hashed squares) measured within each different ward at time of observation is indicated (horizontal bars indicate the lower and upper limits of 95% confidence intervals). Data are from Pittet et al.[3]

bedside was of paramount importance to improve compliance.

2. Compared to previous studies, the variation in staffing patterns measured by the patient:personnel ratio was small in seven of the eight German ICUs (intrahospital range, ≤0.4). Moreover, with only two 8-hour observation periods in each unit, the study period was probably too short to evaluate the exposure of interest. In contrast, Vicca[5] recently offered an excellent illustration of the contribution of understaffing to the spread of methicillin-resistant *Staphylococcus aureus* (MRSA) as a surrogate marker for low hand-hygiene compliance. In this study, the trough values for the patient:nurse ratios were more widely separated (range, 0.6-2.5) during several months of observation, demonstrating a weak but significant correlation between new MRSA cases and varying staffing levels. As proposed by Fridkin et al,[6] there may be a critical staffing threshold level below which optimal patient care becomes difficult, causing inadequate device manipulations and increased nosocomial infection rates. Probably this critical level was not reached in the studied German ICUs.

3. We appreciate the thoughtful comment about using crude patient:nurse ratios. Indeed, as described in our article,[1] more refined work-load measurement instruments should be used for this type of investigation, to adjust for the severity of patient care and associated nursing duties. In addition, the accuracy of correlating work load with hand-hygiene compliance and nosocomial infections may increase by considering the varying skill and training levels of the healthcare workers.[7,8] Substitution of well-trained nurses by temporary pool nurses may have a substantial impact on the quality of patient care and should be studied in more detail in future studies.

4. The relation between staffing patterns and compliance with hand hygiene is complex. As shown in the Figure (based on recently published data[3]), compliance across hospital wards varied mainly according to the number of opportunities for hand hygiene per hour of patient care (dark circles, hashed bar). The latter remained an independent predictor of noncompliance even after correction for confounding factors such as the patient:nurse ratio (hashed squares).[3]

In summary, we have to recognize that the association between understaffing, overcrowding, and hand-hygiene compliance is not a linear cause-effect relation, but consists of the interaction of several factors exhibiting synergistic effects, and may be flawed by various methodological shortcomings, including publication bias. Whatever the limitations of previous epidemiological studies on this topic, the evidence that cost-driven downsizing and changes in staffing patterns causes harm to patients can no longer be ignored.

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The writers report the results of two observational studies in eight medical-surgical intensive care units in Germany to determine the frequency of hand washing by the medical staff and plot these results against the patient:personnel ratio. They conclude that decreasing the patient:personnel ratio is not associated with improved compliance with hand disinfection before patient-care procedures.

While the writers point out several concerns with their conclusions, they may also be right. Increasing the number of staff alone may not be sufficient to assure good practice. They make no mention of ongoing educational programs or that the performance statistics they collected on hand washing were provided to the staff in the interval between measurements.

The components of a successful program are likely to include a well-designed unit with sufficient handwashing sinks and sufficient personnel to cohort groups of patients functionally; but, performance information, provided on an ongoing basis to the staff